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ANALYSIS OF RATES OF INTENSIFICATION OF DOUGLAS-FIR DWARF MISTLETOE IN MIXED CONIFER STANDS IN THE SOUTHWEST

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Analysis of Rates of Intensification of Douglas-fir Dwarf Mistletoe in Mixed Conifer Stands in the Southwest

Revised Final Report

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EXPERIMENT STATION

During 1986 a total of 120 Douglas-fir dwarf mistletoe ten-year intensification plots were completed in a total of 24 mixed conifer stands in the Apache-Sitgreaves National Forest, Arizona. Site indexes, stand histories, habitat types, stand densities, and diameter class/dwarf mistletoe rating (DMR) data for those plots were summarized in the first field season progress report submitted to the U. S. Forest Service in January, 1987. However, because the 1986 plots were all located on the Apache-Sitgreaves National Forest, summaries for the 1987 data from the Apache-Sitgreaves National Forest include the 1986 data also.

From June 1 through August 30, 1987 a total of 180 Douglas-fir dwarf mistletoe ten-year intensification plots were completed in a total of 37 mixed conifer stands on the Alpine Ranger District, Apache-Sitgreaves National Forest. No plots were located on the Springerville Ranger District because of extensive recent logging activity there. From September 15 through November 15, 1987 a total of 85 Douglas-fir dwarf mistletoe ten-year intensification plots were completed in 17 mixed conifer stands on the Cloudcroft Ranger District, Lincoln National Forest, New Mexico and a total of 40 Douglas-fir dwarf mistletoe ten-year intensification plots were completed in 8 stands on the Penasco Ranger District, Carson National Forest, New Mexico. Therefore, a total of 305 Douglas-fir dwarf mistletoe ten-year intensification plots were completed in a total of 62 southwestern mixed conifer stands in 1987, bringing the total number of plots completed to 425 in a total of 86 stands.

A summary of Douglas-fir site index classes (less than 75 feet, 75 to 90 feet, and greater than 90 feet) for each national forest sampled and for all national forests is presented in Table 1. The total number of Douglas-fir dwarf mistletoe ten-year intensification plots sampled representing Douglas-fir site indexes less than 75 feet (114 plots) and greater than 90 feet (126 plots) meets study plan guidelines for site index sampling (pages 5 - 6 of work plan). Stand histories and habitat types sampled in 1986 and 1987 are summarized in Table 2. Douglas-fir dwarf mistletoe ten-year intensification plots were primarily located in stands representing the Abies concolor/Quercus gambelii (140 plots), Abies concolor/Erigeron eximius (68 plots), Abies concolor/Berberis repens (70 plots), Abies concolor/Festuca arizonica (55 plots), and Picea engelmannii/Senecio cardamine (53 plots) habitat types. A summary of Douglas-fir dwarf mistletoe ten-year intensification plots sampled by stand density classes (basal area less than 100 square feet/acre, 100 to 160 square feet/acre, and basal area greater than 160 square feet/acre) for 1986 and 1987 data combined is presented in Table 3. Most plots sampled represent mixed conifer stands with basal areas greater than 160 square feet/acre. Work plan guidelines for stand density sampling (work plan page 6) were met.

A tabulation of the 300 Douglas-firs sampled from the Apache-Sitgreaves National Forest by diameter classes (0.1 - 5.0 inches, 5.1 - 10.0 inches, 10.1 - 15.0 inches, and greater than 15.0 inches) and dwarf mistletoe ratings (DMR 1-6) is presented

in Table 4. At least ten trees representing each diameter class/DMR combination were sampled except for trees with a diameter greater than 15.0 inches and a DMR of 4 where only nine trees were sampled. A tabulation of the 125 Douglas-firs sampled in New Mexico in 1987 (Lincoln and Carson National Forests) by the above diameter classes and DMR combinations is presented in Table 5. At least five trees representing each diameter class/DMR combination were sampled except for Douglas-firs with a diameter greater than 15.0 inches and a DMR of 6 where only four trees were sampled.

A summary for all Douglas-firs sampled in 1986 and 1987 by the above diameter and DMR classes and by the number of "influence trees" (none, few, or many[1]) surrounding individual sample trees is presented in Table 6. Work plan guidelines (Pages 7 - 8) for sampling infected Douglas-firs with no influence trees, few influence trees, and many influence trees for the combined Arizona and New Mexico data set were met, except that no sample trees could be located with the following diameter class/DMR/influence tree combinations:

	Diameter Class (inches)	DMR	Number of Influence Trees
1.	0.1 - 5.0	4	None
2.	0.1 - 5.0	5	None
3.	0.1 - 5.0	6	None
4.	5.1 - 10.0	2	None
5.	10.0 - 15.0	4	None

[1] The terms "few" and "many" are defined on page 8 of the work plan.

A listing of all stand, tree, and plot data for Douglas-fir

dwarf mistletoe intensification plots completed in 1986 was compiled in December, 1986. All data was transferred to computerized data files using an IBM PC microcomputer at Northern Arizona University. The 1986 field data and a progress report summarizing 1986 field data collection was submitted to the Forest Service in January, 1987. All 1987 field data was transferred into computerized data files from November 16 through December 5, 1987. Three separate data files were compiled for the 1987 data:

1) STAND10: This file contains all stand data for stands sampled in 1986 and 1987 using the ten-year intensification method (86 stands). A few errors were detected in the 1986 data and corrected in this file. See Appendix A for file format.

2) TREE101987: This file contains the individual sample tree data for the 305 Douglas-firs sampled in 1987. It does not include any of the 1986 data. See Appendix B for file format. Note that the file format is slightly different from the 1986 data set.

3) PLOT101987: This file contains all of the plot data collected in 1987 (305 plots). It does not include plot data for 1986. See Appendix C for file format. Note that the file format is different from the 1986 data set.

The above data files were transferred from disk storage on the Northern Arizona University Honeywell CP-6 computer to 5 1/4 inch floppy disks on an IBM PC microcomputer (DOS 2.1) and were submitted with the final report.

Some difficulties encountered with the Douglas-fir dwarf mistletoe ten-year intensification method for estimating mistletoe intensification were:

1) Data collection procedures are labor intensive in that it takes a considerable amount of time to cut sample trees, demarcate present and past live crown thirds, dissect questionable individual dwarf mistletoe infections to ascertain whether they are greater than ten years old, and age the apparent oldest infection when present. Furthermore, the time required to locate trees in specific diameter class/DMR combinations increased as the study proceeded. It was possible to sample nearly all of the diameter class/DMR combinations required, but more trees could have been sampled during the study if less emphasis would have been placed on this sampling criteria.

2) When large trees (diameters greater than 15.0 inches) were cut, many branches were destroyed and could not be recovered easily from the underside of the trees. This often made determination of present and past DMR's difficult. In some cases the DMR's had to be based on estimates.

3) Demarcation of the past live crowns was often difficult on large trees that had many dead branches below the present live crown. However, because large trees usually had not grown more than a foot in ten years, using the bottom of the present live crown as the bottom of the past live crown was probably an accurate representation of the past live crown location.

Table 1. Plots sampled by Douglas-fir site index classes and national forests.

National Forest	Site Index Class (feet)		
	Less Than 75	75 - 90	Greater Than 90
Apache-Sitgreaves	89	125	86
Carson	15	25	0
Lincoln	10	35	40
Total	114	185	126

Table 2. Distribution of plots sampled by stand history and habitat type.

Stand History	Number of Plots
Undisturbed	50
Disturbed 12-20 Years Prior to Sampling	155
Disturbed 21-30 Years Prior to Sampling	185
Disturbed Over 30 Years Prior to Sampling	35
Total	425

Habitat Type	Number of Plots
Abies concolor / *Quercus gambelii*	140
Abies concolor / *Erigeron eximius*	68
Abies concolor / *Berberis repens*	70
Abies concolor / *Festuca arizonica*	55
Picea engelmannii / *Senecio cardamine*	53
Picea pungens / *Fragaria ovalis*	29
Picea pungens / *Erigeron eximius*	5
Abies concolor / *Acer glabrum*	5
Total	425

Table 3. Distribution of plots sampled by stand density classes.

Stand Density Class (square feet/acre)	Number of Plots
Less than 100	139
100-160	111
Greater than 160	175
Total	425

Table 4. Douglas-firs sampled by diameter class and dwarf mistletoe rating on the Apache-Sitgreaves National Forest.[1]

Diameter Class (inches)	Dwarf Mistletoe Rating 1	2	3	4	5	6	Total
0.1-5.0	14	13	13	13	12	11	76
5.1-10.0	15	13	12	12	13	15	80
10.1-15.0	11	11	12	12	14	11	71
15.1+	13	12	16	9	12	11	73
Total	53	49	53	46	51	48	300

[1] 1986 and 1987 data combined.

Table 5. Douglas-firs sampled by diameter class and dwarf mistletoe rating in New Mexico.[1]

Diameter Class (inches)	Dwarf Mistletoe Rating 1	2	3	4	5	6	Total
0.1-5.0	5	5	5	5	5	5	30
5.1-10.0	6	6	5	5	5	5	32
10.1-15.0	6	5	5	5	5	5	31
15.0+	6	6	5	5	6	4	32
Total	23	22	20	20	21	19	125

[1] Carson and Lincoln National Forests combined.

Table 6. Distribution of Douglas-firs sampled by diameter class, dwarf mistletoe rating, and number of influence trees.

DMR	Diameter Class (inches) 0.1-5.0	5.1-10.0	10.1-15.0	15.0+
	No Influence Trees			
	(0[1])	(0)	(0)	(0)
	Number of Trees			
1	1	1	2	2
2	1	0	3	4
3	1	1	1	3
4	0	1	0	2
5	0	2	1	2
6	0	2	3	3
Total	3	7	10	16
	Few Influence Trees			
DMR	(1-5)	(1-4)	(1-3)	(1-2)
	Number of Trees			
1	9	17	10	11
2	9	12	9	11
3	11	9	10	8
4	6	7	12	6
5	9	8	8	6
6	12	14	6	6
Total	56	67	55	48
	Many Influence Trees			
DMR	(6+)	(5+)	(4+)	(3+)
	Number of Trees			
1	9	2	5	5
2	8	7	4	4
3	6	7	7	10
4	12	9	5	6
5	8	8	10	10
6	4	4	7	6
Total	47	37	38	41

[1] Number of influence trees in parentheses.

Appendix A
Format For Data File Stand10

Format	Variable
A4	Study(DFDM)
I3	Stand Number
A8	National Forest
A2,I2,A1	Township
A2,I2,A1	Range
A4,I3	Section
I3	Number of Plots (Trees)
I5	Elevation
I3	Slope Code
I2	Slope Position Code
I2	Aspect Code
I3	Habitat Type Code
I4	Douglas-fir Site Index
I2	Stand History Code
I5	Date Disturbed

Appendix B

Format For Data File Tree101987

Format	Variable
A4	Study(DFDM)
I3	Stand Number
I4	Plot Number
F4.1	Diameter Breast Height
I2	Crown Class Code
I2	Estimated Standing DMR
I2	Standing DMR - Bottom Third
I2	Standing DMR - Middle Third
I2	Standing DMR - Top Third
I2	1987 DMR - Total
I2	1987 DMR - Bottom Third
I2	1987 DMR - Middle Third
I2	1987 DMR - Top Third
I2	1977 DMR - Total
I2	1977 DMR - Bottom Third
I2	1977 DMR - Middle Third
I2	1977 DMR - Top Third
I4	1987 Total Height
I3	1987 Height Live Crown
I4	1977 Total Height
I3	1977 Height Live Crown
I4	DBH Age
I3	Oldest Infection Age
F4.2	Ten-year Growth
F4.2	Twenty-year Growth
I3	Plot Radius (feet)

Appendix C

Format For Data File Plot101987

Format	Variable
A4	Study(DFDM)
I3	Stand Number
I4	Plot Number
I3	Tree Number
I2	Species Code
I3	Diameter Breast Height
I2	DMR of Douglas-firs
I2	Crown Class Code
I2	Screen Tree Code
I2	Crown Ratio Code
I4	Total Height
I3	Height Live Crown

Appendix D

Data Codes

Aspect:

1 - North
2 - South
3 - West
4 - East
5 - Northwest
6 - Northeast
7 - Southwest
8 - Southeast

Slope Position:

1 - Slope
2 - Flat
3 - Ridge
4 - Bottom

Habitat Type:

1 - ABCO/EREX
2 - PIEN/SECA
3 - ABCO/BERE
4 - PIPU/FROV
5 - PIPU/EREX
6 - ABCO/QUGA
7 - ABCO/ACGL
8 - ABLA/EREX
9 - ABCO/FEAR

Species:

1 - Douglas-fir
2 - Ponderosa pine
3 - White fir
4 - Blue spruce
5 - Engelmann spruce
6 - corkbark fir
7 - Southwestern white pine
8 - Aspen
9 - Other

Crown Class:

1 - Dominant
2 - Codominant
3 - Intermediate
4 - Suppressed or overtopped
5 - Dead 0-5 years
6 - Dead 6-10 years
7 - Dead over 10 years

Stand History:

0 - Virgin or relatively undisturbed
1 - Overstory harvest
2 - Thinned
3 - Burned

Compact Crown Ratio:

0 - Dead tree
1 - 10-14%
2 - 15-24%
3 - 25-34%
4 - 35-44%
5 - 45-54%
6 - 55-64%
7 - 65-74%
8 - 75-84%
9 - 85-100%

Screen Tree Column Code:

1 - Screen Tree
2 - Influence Tree
3 - Screen tree and influence tree

Addendum

A separate data file was compiled (TREE1187) which includes the variables listed in Appendix E. This file is a modification of the data file submitted to the Forest Service with the 1986 progress report. It includes all of the data contained in the data files TREE10 (1986 individual tree data) and TREE101987 (1987 individual tree data), and the following variables:

1. Plot Radius (feet)
2. Total Plot Basal Area (square feet/acre)
3. Basal Area of Screen Trees (square feet/acre)
4. Number of Screen Trees
5. Mean DMR of Influence Trees
6. Number of Influence Trees
7. Douglas-fir Site Index (feet)
8. Habitat Type Code (See Appendix D)
9. Stand History Code (See Appendix D)
10. Years Since Stand Disturbance

Note that the format for data file TREE1187 is different from the format for the 1986 data file TREE11. The plot radius has been added for each line in TREE1187 instead of the data for the plot area and the data for variables such as 1986 DMR/Oldest Infection Age and DBH Age-Oldest Infection Age have been removed.

Table 7. Conversion Listing for Habitat Types Used in 1980-81 to Habitat Types Used in 1986-87.

Habitat Types and Codes Used in 1980-1981		Habitat Types and Codes Used in 1986-1987 or New Name[1,2]	
Code	Habitat Type	Code	Habitat Type
1	ABLA/ERSU	Not Used	ABLA/EREX
2	PIPU-PIEN/SECA	2	PIEN/SECA
3	PIPU-PIEN/ERSU	4	PIPU/FROV
4	ABCO-PSME	3	ABCO/BERE
5	ABCO-PSME/ERSU	1	ABCO/EREX
6	ABCO-PSME/POFE	9	ABCO/FEAR
7	ABCO-PSME/QUGA	6	ABCO/QUGA
8	ABLA/RUPA	Not Used	ABLA/RUPA
9	PSME-PIST/MUVI	Not Used	PSME/MUVI
10	ABCO-PSME/ACGL	7	ABCO/ACGL
11	ABCO/ACGR	Not Used	ABCO/ACGR
12	PSME/FEAR	Not Used	PSME/FEAR
13	ABLA/VASC-LIBO	Not Used	ABLA/VAMY
14	PIPU/PSME	5	PIPU/EREX
15	PIPU/CAFO	Not Used	PIPU/CAFO
16	PIEN/ACGL	Not Used	PIEN/ACGL
17	PSME/PHMO	Not Used	PSME/HODU
18	ABLA/JUCO	Not Used	ABLA/JUCO
19	ABCO/FEAR	9[3]	ABCO/FEAR
20	PSME/QUHY	Not Used	PSME/QUHY

[1] Alexander, R. R. 1985. Major habitat types, community types, and plant communities in the Rocky Mountains. USDA Forest Service General Technical Report RM-123, 105 p.

[2] Alexander, R. R., and F. Ronco. 1987. Classification of the forest vegetation on the national forests of Arizona and New Mexico. USDA Forest Service Research Note RM-469, 10 p.

[3] The ABCO-PSME/POFE habitat type is now considered to be the ABCO/FEAR habitat type, therefore, there are two listings for code number 9 under the habitat types used in 1986-1987.

Intensification of Douglas-fir Dwarf Mistletoe in Mixed Conifer Stands in the Southwest

Variable Documentation

Objectives

1. Determine estimates of ten-year intensification for Douglas-fir dwarf mistletoe in southwestern mixed conifer stands.

2. Develop and evaluate methodologies for meeting objective 1.

3. Collect additional data on diameter/age relationships for tree species found in southwestern mixed conifer forests.

Geographic and Ecological Description of Sample Population

Plots were selected in southwestern mixed conifer stands in the White Mountains, Arizona (Apache-Sitgreaves National Forest, Alpine Ranger District), the Sacramento Mountains, New Mexico (Lincoln National Forest, Cloudcroft Ranger District), and the southern Sangre de Cristo Mountains of northern New Mexico (Carson National Forest, Penasco Ranger District). Plots were selected in stands representing the mixed conifer forest type, dominated by Douglas-fir, and infested with Douglas-fir dwarf mistletoe. Stands selected were generally multi-storied, uneven-aged, and had not had significant disturbance in the 10 years prior to data collection. Significant disturbance refers to any type of intermediate cutting, overstory harvest, or fire activity in the stand. Stands with only a few, scattered stumps of any size were not considered to be significantly disturbed. The large majority of stands selected represented habitat types in the Abies concolor series.

Plot Selection Criteria

Plots were selected in stands that represent the southwestern mixed conifer forest type, were infested with Douglas-fir dwarf mistletoe, and had not been significantly disturbed in the 10 years prior to data collection. Two to five plots were selected in each stand sampled. Plots were selected on the basis of the sample tree. The diameter class of the tree and the level of dwarf mistletoe infection were the two main criteria for selecting sample trees. Sampling criteria stratified the sample trees by four diameter classes (dbh 0.1 - 5.0 inches, dbh 5.1 - 10.0 inches, dbh 10.1 - 15.0 inches, and dbh greater than 15.0 inches) and six dwarf mistletoe ratings (dwarf mistletoe rating 1 - 6). An attempt was made to sample at least 15 trees for each cell of the diameter class/dwarf

mistletoe rating matrix. Plot size (plot radius in feet) was determined by measuring the distance from the center sample tree to the farthest dwarf mistletoe infected Douglas-fir that could act as an inoculum source for the central sample tree. The distance could not exceed a maximum of 35 feet to the live crown of the tree serving as the inoculum source. Plot radius was measured to the base of the farthest inoculum source, however.

Plot Design

Refer to first paragraph on page 5 of revised work plan. Change the third sentence in the paragraph to read as follows:

The following data will be determined for each tree greater than 4.5 in height within each circular plot: diameter at breast height (nearest 1.0 inch), species (Appendix B), and crown class (Appendix B).

Variable Descriptions

Stand Data Variables

Plot Radius (radius): Distance to nearest foot from central sample tree to farthest influence tree with live crown within 35 feet of the sample tree. Radius distance measured from base of sample tree to base of farthest influence tree, so radius could be greater than 35 feet.

Stand Location (forest, township, range, section): Forest, township, range, and section were determined from U. S. Forest Service National Forest maps.

Elevation (elev): Estimated from U. S. Geological Survey topographic maps to the nearest 100 feet.

Slope (slope): Clinometer reading to nearest 5 percent from center of plot. One reading upgrade only.

Slope Position (position): Ridgetop, bottom, slope, or flat. Ridgetop - Use description in code descriptions for SWDF DM Mortality Study for ridgetop. It fits perfectly for this study.

Bottom - Use description for Bottoms or Draws as above.

Slope - Use description for Dry Sidehills and Dry Mountain Slopes as above.

Flat - Use description for Dry Flats as above.

Aspect (aspect): Compass direction toward which the majority of land slopes on the plot.

Habitat Type (habitat): See Plant Association and Phase description for SWDF DM Mortality Study. Description applies to this study.

Habitat Types Sampled for SWDF DM Intensification Study:

ABCO/QUGA, ABCO/EREX, ABCO/BERE, ABCO/FEAR, PIEN/SECA, PIPU/FROV, PIPU/EREX, and ABCO/ACGL.

Use same reference list as for SWDF DM Mortality Study, but add:

E. L. Fitzhugh, W. H. Moir, J. A. Ludwig, and F. Ronco. 1987. Forest habitat types in the Apache, Gila, and northern part of the Cibola National Forests, Arizona and New Mexico. USDA Forest Service General Technical Report RM-145, 116 p.

Douglas-fir Site Index (site): See revised work plan page 6, second paragraph for description of site index tree selection criteria. The Douglas-fir site index curves used were:

Edminster, C. B., and L. H. Jump. 1976. Site index curves for Douglas-fir in New Mexico. USDA Forest Service Research Note RM-326, 3 p.

Stand History (history): Virgin, overstory harvest, thinned, or burned.

Virgin - No evidence of significant disturbance has occurred in the stand. Stand could have a few, scattered stumps of any size in stand, but no indications of any type of overstory removal or intermediate cutting could be evident. Stands with a large aspen component were considered to have been burned.

Overstory Harvest - Evidence that the stand had some type of overstory removal. Many large stumps found in stand. Stand more open than typical virgin southwestern mixed conifer stand. Logging scars usually evident on residual overstory trees.

Thinned - Evidence of intermediate cutting. Many small stumps found scattered in the stand.

Burned - Obvious fire scars on trees or stand composed of mostly aspen with other species scattered in the stand.

Approximate Date of Disturbance (date): Approximate dates of overstory harvests and thinning were determined from logging scar callus formation, changes in radial growth patterns on increment cores (release), or from U. S. Forest Service records for the stand.

Two years were added to the release age to allow for trees to respond to management activity. In some stands release dates and logging scars were cross-checked. Approximate burned dates were determined from callus formation on fire scars or from averaging the total ages of three dominant aspens in a stand.

Tree Data Variables

DBH (cdbh): Measured to the nearest 0.1 inch with diameter tape at 4.5 feet above the ground on the uphill side of tree.

Crown Class (ccc): Dominant, codominant, intermediate, and suppressed, dead 0-5 years, dead 6-10 years, dead over 10 years.

See description for the first four crown class categories above in SWDF DM Mortality Study documentation. The descriptions apply to this study.

Dead 0-5 years - Approximate number of years tree had been dead. Primarily based on bark condition, number and condition of branches left on tree, or presence of dead needles. This classification is subjective.

Dead 6-10 years - See description for dead 0-5 years. This classification was even more difficult to rate trees that had recently died. Data for this variable is not reliable.

Dead over 10 years - Trees that had little intact bark or few branches. Estimates for this variable are more reliable than for dead 6-10 years.

Dwarf Mistletoe Ratings: The standard 6-class system (Hawksworth 1977) was used.

Hawksworth, F. G. 1977. The 6-class dwarf mistletoe rating system. USDA Forest Service General Technical Report RM-48, 7 p.

Standing DMR (dmst): Dwarf mistletoe rating that was determined when tree was still standing. Visual estimate of DMR by dividing live crown into thirds and rating each third of the live crown separately. No ocular aids were used. Time to rate trees varied considerably among sample trees. Large trees with moderate DMR's (DMR 3 or 4) usually took longer than large or small trees with heavy or light mistletoe infection. The total DMR and ratings for each third of the live crown were recorded separately.

Actual or Current DMR (dmct): Tree was cut, live crown was measured with measuring tape to nearest foot, and live crown was divided into thirds using measuring tape. Then the number of

infected live branches in each third was determined and each third was assigned a rating of 0, 1, or 2. If a third of the live crown was obviously a 1 or 2 the number of live infected branches were not counted. Only thirds that were questionable were critically analyzed for mistletoe infections. The total DMR and ratings for each third of the live crown were recorded separately.

Initial DMR (dmit): The DMR of the tree ten years prior to data collection was determined by dissecting and aging individual mistletoe infections in each third of the live crown that was estimated to exist at that point in time. The length of the past live crown was estimated by counting ten branch whorls down from the terminal leader of the tree and measuring to the point on the main stem where the past live crown was estimated to have existed. The bottom of the past live crown was defined as the point where recently dead branches were no longer present on small trees (usually trees less than 15.0 inches in diameter) and as the bottom of the current live crown for large trees (trees larger than 15.0 inches in diameter). For trees larger than 20.0 inches in diameter the current live crown was used for the past live crown. After the length of the past live crown was estimated it was divided into thirds. The number of mistletoe infections less than ten years old were then determined for each third of the past live crown by dissection and aging of individual infections using the technique described by Scharpf and Parmeter (1966). Only one year was added to the determined age of infection to allow for establishment of infection by Douglas-fir dwarf mistletoe. The DMR was determined for each third of the past live crown by totaling the number of infections less than ten years old and the number of live healthy branches and comparing it with the number of live branches with infections greater than ten years old. If the total of healthy live branches and live branches with infections less than ten years old was less than the number of live branches with infections greater than ten years old in a third of the live crown, that third was rated as a 2. If the total just described was greater than the number of live branches with infections greater than ten years old, then that third was rated as a 1. If no live branches in a third of the past live crown had infections greater than ten years old or if no live branches were infected then the third was rated as a 0. The total DMR for the tree ten years prior to data collection and the DMR for each third were recorded separately.

Scharpf, R. F., and J. R. Parmeter. 1966. Determining the age dwarf mistletoe infections on red fir. USDA Forest Service Research Note PSW-105, 5 p.

Current Total Height (cht): Total height was measured to the nearest foot with a measuring tape from the top of the terminal leader to the base of the tree after the sample tree was cut.

Current Height to Live Crown (chtlc): The bottom of the live crown was defined as the point on the main bole where live, healthy branches stopped. If only one live branch was present at this point and a gap of not over five feet occurred to the next whorl of live branches above it, the single branch was considered to be the bottom of the live crown. If a gap over 5 feet occurred, the bottom of the live crown was considered to be located at the next whorl of live branches up from the single live branch. If more than one live branch occurred below a gap of five feet, the branches were considered to be the bottom of the live crown unless they were more than 10 feet below the main section of the live crown. When the branches were more than 10 feet below the main crown the bottom of the main live crown was used for the live crown measurement. Live branches separated from the main crown by more than 10 feet were not visually move up to be part of the main live crown. Height to live crown from the ground was measured to the nearest foot with a measuring tape after the sample tree was cut.

Initial Total Height (iht): See description for determination of initial DMR above for description of how initial total height was determined and measured.

Initial Height to Live Crown (ihtlc): See description for determination of initial DMR above.

DBH Age (age): Determined by counting annual rings on increment core extracted at 4.5 feet above the ground on uphill side of tree.

Oldest Infection Age (oldest): Age of infection on apparent oldest witches' broom on sample tree. The apparent oldest broom was dissected and the age of infection determined using the technique described by Scharpf and Parmeter (1966). One year was added to the age of infection to allow for establishment of Douglas-fir dwarf mistletoe infection. Determination of what constituted oldest brooms was highly subjective. Therefore, the data for this variable contains a large amount of biased sampling error and is not very reliable.

Radial Growth for the Past Ten and Twenty Years (rg10 and rg20): Radial growth was measured to the nearest 0.05 inch on each increment core extracted for determination of breast height age. See description of DBH age determination method above. The values for radial growth do not represent diameter growth.

Plot Data Variables

DBH (cdbh): Visually estimated to the nearest 1.0 inch.

DMR (dmst): Determined for Douglas-fir using the standard 6-class system described by Hawksworth (1977). In 1986 it was only recorded for infected Douglas-firs with live crowns within 35 feet of the central sample tree and large enough to serve as a potential infection source for the sample tree (influence trees). For example, a five foot tall infected Douglas-fir 20 feet from a 60 foot tall central sample Douglas-fir would not have had a DMR recorded for it in 1986 or 1987. It would not be considered an influence tree because it is unlikely mistletoe seeds from the 5 foot tree could reach the live crown of the 60 foot tree. On the other hand, a five foot infected Douglas-fir beside a 10 foot central sample tree would be considered an influence tree and its DMR would have been recorded. In 1987 the DMR for all live Douglas-firs in a plot were recorded, but a separate status code was assigned for influence trees. The classification of influence trees was subjective in that field crews based the classification on field observations such as infection level of potential influence trees, total height of tree, distance from central sample tree, and height of infections in live crown relative to distance from central sample tree.

Crown Class (ccc): Dominant, codominant, intermediate, and suppressed, dead 0-5 years, dead 6-10 years, dead over 10 years.

See descriptions for crown class categories above.

Screen Tree or Influence Tree (status):

Influence Tree - See description of influence trees under DMR directly above.

Screen Tree - Any tree that could act to intercept (screen) mistletoe seeds from contacting the central sample tree. These trees could be any species in the plot, including Douglas-firs. Therefore, an infected Douglas-fir could be both a screen tree and an influence tree. No quantitative criteria were used for determining screen trees. If a tree was located between an influence tree and the central sample tree and was large enough to intercept seeds from the influence tree it was considered a screen tree. Very small trees that could probably not intercept seeds were not considered screen trees in most cases. The designation of screen trees and influence trees was a subjective decision based on field observations.

Crown Ratio (ccr): Visually estimated to nearest five percent. See data codes and see description of crown ration in the SWDF DM Mortality Study documentation.

Total Height (cht): Every tenth tree in plots was measured for total height to the nearest foot using a clinometer.

Height to Bottom of Live Crown (chtlc): Measured to the nearest foot with a clinometer for trees measured for total height. See description of live crown determination above.

Remeasured SWMC Plots

Appropriate variable descriptions above apply to this data set, except that heights to whorls 5 and 10 were not described above.

Height to 5th Whorl (htw5): Height from ground to 5th whorl from top of tree. Measured to the nearest foot with clinometer when possible to ascertain 5th whorl on tree. Only measured on trees that were measured for total height.

Height to 10th Whorl (htw10): Height from ground to 10th whorl from top of tree. Measured to the nearest foot with clinometer when possible to ascertain 10th whorl on tree. Only measured on trees that were measured for total height.

Status: Refers to trees that are dead or alive in 1986. One represents alive and two represents dead.